

## THE NOMENCLATURE OF MINERALS.

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(Received May 14, 1913.)

About five thousand mineral names are in use or have been proposed.<sup>1</sup> These names are, of course, mainly varieties and synonyms. Many of them have been discarded and are gradually disappearing from the literature. Even some of the Germans are dropping such names as *kupferglanz* and *eisenkies* and are using the international names, chalcocite and pyrite in this instance. Thanks to the fifth edition of Dana's "System of Mineralogy" the synonymy has been pretty thoroughly worked out and most of the names used for the distinctive minerals are well established.

Though there are about five thousand mineral names, there are not more than a thousand distinctive minerals.<sup>2</sup>

The distinctive minerals are usually called "simple minerals," "definite minerals," "mineral species," or "definite mineral species." It is necessary to use some such term, for the word mineral is used (1) as a general term for the inorganic constituents of the earth's crust, (2) in a popular way for a metallic substance of commercial value that is mined or quarried and (3) in a restricted sense for a natural inorganic substance of definite chemical composition.<sup>3</sup>

The term most used is "mineral species," borrowing a biological term. In this connection it is interesting to note that a binominal

<sup>1</sup> The most complete list of mineral names available is found in the "Mineralogisches Taschenbuch" of the Vienna Mineralogical Society published at Vienna in 1911.

<sup>2</sup> In Dana's "System" and Appendices up to the year 1909, 951 minerals are given. In Groth's "Tabellarische Uebersicht der Mineralien" (1908) there are 829. In the "Mineralogisches Taschenbuch" of the Vienna Mineralogical Society (1911) there are 972 (including 22 hydrocarbons not given by Dana and Groth). So the number of distinctive minerals is, in round numbers, 1,000.

<sup>3</sup> For an interesting discussion of the use of the word mineral see an article by J. W. Gregory, *Trans. Institution of Mining Engineers*, 1909.

nomenclature like that now used for plants and animals was at one time used for minerals. In the first (1837) and second (1844) editions of Dana's "System of Mineralogy" binominal names<sup>4</sup> were given along with the usual names, mostly ending in *-ite*. Thus barite was known as *Baralus ponderosus* and celestite as *Baralus prismaticus*. The genus *Baralus* also included witherite, strontianite, and barytocalcite. Classes and orders were also recognized. The classification used then was the natural history classification of Werner and Mohs based upon external characters.

This gradually gave way to the chemical classification of Berzelius and the Swedish chemists. In the third edition (1850) of Dana's "System" the chemical classification was adopted and the binominal names, even as synonyms, were rejected.

A mineral species is a mineral with definite chemical composition and distinctive crystal form (or crystalline structure). "Definite" must be interpreted in the light of isomorphism, including mass-effect isomorphism first recognized by Penfield.<sup>5</sup> It is also necessary to recognize solid solutions of a kind different from isomorphism.<sup>5a</sup> Pyrrhotite,<sup>6</sup> for example, is a solid solution of sulfur, S, in ferrous sulfid, FeS. Nephelite,<sup>7</sup> is a solid solution of  $\text{NaAlSiO}_4$ ,  $\text{KAlSiO}_4$  and  $\text{NaAlSi}_3\text{O}_8$ , of which only the first two are isomorphous.

Crystal form must also be used in defining a mineral species for polymorphous minerals are distinct and are often strikingly different in physical properties as in the extreme case of diamond and graphite. Some of the dimorphous minerals have distinctive names (*e. g.*, calcite, aragonite) but there is a tendency to use a prefix before the first known mineral for the dimorphous form. Thus we have clinozoisite, paralaurionite, pseudowollastonite, metaboracite,

<sup>4</sup> These binominal names were first suggested by Dana in an article in the fourth volume of the *Annals of the New York Lyceum*.

<sup>5</sup> That is, in large molecules dissimilar elements or groups may replace each other. See *Amer. Jour. Sci.* (4), Vol. 7, p. 97, 1899.

<sup>5a</sup> Küster (*Zeit. für phys. Chem.*, Vol. 17, p. 367, 1895) maintains that a distinction should be made between solid solutions and isomorphous mixtures.

<sup>6</sup> Allen, Crenshaw, and Johnston, *Amer. Jour. Sci.* (4), Vol. 33, p. 193, 1912.

<sup>7</sup> Bowen, *Amer. Jour. Sci.* (4), Vol. 33, p. 49, 1912.

and neotantalite for the dimorphous forms of zoisite, laurionite, wollastonite, boracite, and tantalite respectively.

Since the rise of colloidal chemistry the question of names for colloidal or amorphous minerals arises. Recently names have been proposed for a few of the naturally occurring amorphous minerals. These substances can hardly be excluded from the list of mineral species as they are definite in composition, unless we insist that a mineral must be crystalline in character. To obviate this difficulty Niedzwiedzki<sup>8</sup> has proposed the term *mineraloid* for the natural amorphous substances. Among examples of colloidal minerals or mineraloids are the following: ostwaldite = colloidal AgCl (buttermilcherz); jordisite = colloidal MoS<sub>2</sub>;  $\alpha$ -klichite = colloidal Al<sub>2</sub>O<sub>3</sub>·H<sub>2</sub>O;  $\beta$ -klichite = colloidal Al<sub>2</sub>O<sub>3</sub>·3H<sub>2</sub>O; ehrenwerthite = colloidal Fe<sub>2</sub>O<sub>3</sub>·H<sub>2</sub>O. The term sulfurite has been proposed for amorphous sulfur and metastibnite for amorphous antimony sulfid. Fortunately there are very few amorphous minerals which are definite enough to be recognized as distinct mineral species<sup>9</sup> but the application of colloidal chemistry to mineralogy will probably increase the number in the future.

Names are used not only for definite chemical compounds, which are often end members of isomorphous series, but also for isomorphous mixtures such as olivine, rhodolite, epidote, and pisanite; for double salts such as dolomite and monticellite; for pseudomorphs such as martite, arkansite, and hampshirite; for mechanical mixtures such as californite and azurlite; for semiprecious or ornamental stones such as bonamite and satellite; for artificial substances such as alite, cementite, silver-analcite, soda-leucite, and carnegieite; for group names such as orthoaugite, clinoaugite, glaucamphibole; and for numerous varieties based upon crystal habit (*e. g.*, adularia), structure (*e. g.*, pholerite, nemalite), color (*e. g.*, melanite, hiddenite, kunzite), unusual optical properties (*e. g.*, isomicrocline, neocolemanite), and variations in chemical composition due either to impurities, (*e. g.*, johnstonite) or to isomorphous replacement (*e. g.*, cuprogoslarite, paravivianite, titanaugite). Varietal names are

<sup>8</sup> *Centralblatt für Min. Geol. u. Pal.*, 1909, p. 661.

<sup>9</sup> Of the more common minerals only opal, bauxite, psilomelane, and allophane are amorphous.

rarely consistent or logical for they are not usually coördinate and not uniform for the various minerals. In the earlier editions of Dana's "System" varieties were greatly subordinated but in the fifth and in the current sixth edition varieties are again given prominence. As Miers<sup>10</sup> has emphasized, the non-essential properties of mineral have received too much attention. The recognition of this fact will naturally lead to the suppression of varietal names as far as possible. While often convenient their use tends to confusion. For example iron-bearing sphalerite has been called marmatite. A sphalerite from Breitenbrunn, Saxony containing eighteen per cent. of iron was named cristophite. Where draw the line between marmatite and cristophite? Sphalerite usually contains more or less iron. If the iron content is notable or needs to be emphasized let it be called ferriferous sphalerite. No special name is necessary.

Names should serve two purposes, which are more or less distinct, namely convenience and accuracy. A name serves a convenient purpose for distinguishing a particular variety or kind of mineral found at a certain locality or one with striking properties found at several localities. But there are so many variations in the properties of minerals that the names multiply too rapidly. Accuracy is not attained for it is very difficult to correlate the different varieties and to define them accurately.

Isomorphism plays a very prominent part in explaining the chemical composition of minerals for many minerals are isomorphous mixtures of two end members. The gaps in isomorphous series are gradually being filled in.

The only satisfactory way of simplifying mineralogical nomenclature is, in my opinion, to name a mineral by its predominant molecule of the isomorphous series to which it belongs. If the mineral is described and named before the isomorphous relations are understood the name still stands for the predominant molecule present. The other names used for varieties, isomorphous mixtures, pseudomorphs, etc., should be discarded, except in a few cases to be mentioned later. Isomorphous mixtures may be indicated by qualifying terms, *e. g.*, ferriferous sphalerite instead of marmatite. The

<sup>10</sup> "Mineralogy," p. 2.

same method can be used with varieties. Thus we can use the term fibrous brucite instead of nemalite.

Such names as soda-orthoclase, natroalunite, ferrogoslarite, and manganocolumbite are ambiguous. Soda-orthoclase may mean an orthoclase in which a portion of the potassium is replaced by sodium or it may mean the sodium compound corresponding to orthoclase. The best method is to use a distinctive name for the monoclinic feldspar in which sodium predominates molecularly over potassium. For such a mineral, which has been found at several localities, Schaller<sup>11</sup> has proposed the name barbierite after the French chemist, Barbier. Note the inconsistency in these compound names. Ferrogoslarite is an iron-bearing zinc sulfate while manganocolumbite is a manganese niobate isomorphous with ferrous niobate. It might be well to restrict these compound names to artificially prepared members of isomorphous series not yet found in nature. Thus we could use the term soda-anorthite instead of carnegieite. The names silver-analcite, soda-leucite, zinc-römerite are examples.

If my suggestions are adopted a number of mineral names will be discarded. Embolite will be either cerargyrite (chlorargyrite) or bromyrite. Petzite will be auriferous hessite. Pisanite will be either cupriferous melanterite or ferriferous boothite. Hyalophane will be barium-bearing orthoclase. Mesitite will be ferriferous magnesite. Nigrine will be ferriferous rutile.

On the other hand, a few new names or resurrected old names will be necessary. Thus the name montebrasite would be resurrected for the basic lithium aluminum phosphate which is isomorphous with amblygonite, lithium aluminum fluo-phosphate. Very few new names will be necessary for synonyms and varieties can often be elevated to the rank of distinct mineral species.

Some exceptions to my rule should be made. The isomorphous mixtures of three or four common and important mineral groups now have distinctive names which should be retained. Thus we have oligoclase, andesine, labradorite, and bytownite in the plagioclase group. Olivine is a convenient name for the isomorphous

<sup>11</sup> *Amer. Jour. Sci.* (4), Vol. 30, p. 358, 1910.



mixture of magnesium and iron orthosilicates but the names hyaloserite and hortonolite in the olivine group are hardly necessary. Epidote is an isomorphous mixture of basic calcium aluminum orthosilicate, clinozoisite, and basic calcium iron orthosilicate, not yet found. Hypersthene is an isomorphous mixture of magnesium metasilicate, enstatite, and ferrous metasilicate, not yet found. It might be well as assign arbitrary limits to olivine, hypersthene, and epidote. This must be done if the names are to be accurate. Dana uses the name hypersthene for orthorhombic pyroxene with ferrous oxid content of over ten per cent. For these various isomorphous mixtures arbitrary divisions similar to those used in the quantitative classification of igneous rocks might be used.

Are the names of mineral species to be arbitrary or can any system of giving names be used? Leaving out the binomial nomenclature there are three possibilities to consider.

1. *Chemical Names.*—As minerals are substances of definite chemical composition purely chemical names will appeal to some as being the simplest and best. But minerals are often complex in composition and the chemical names would be long and cumbersome. While accurate they are not convenient. Moreover the name of a mineral connotes certain physical properties. Calcite is more than calcium carbonate. It is calcium carbonate with certain definite physical properties. The chemist would obviate this difficulty by using the term  $\alpha$ -CaCO<sub>3</sub> for calcite and  $\beta$ -CaCO<sub>3</sub> for aragonite. Except for the elements, perhaps, distinctive names are preferable to chemical names.

2. *Arbitrary Names.*—The names used at present are derived from the locality at which the mineral was first found, from the name of the person who discovered or described the mineral, or they are based upon some prominent physical or chemical characteristic. They are arbitrary and without system except that most of them end in *-ite* (from the Greek and Latin *-itis* or *-ites*, which was added to a word signifying a quality, use, or locality of the mineral). Among other terminations are *-ane*, *-ine*, *-ase*, *-ote*, *-ole*, and *-ome* while older names include galena, quartz, garnet, etc. Some of the names have a chemical significance but even they are

in part arbitrary. Cuprite might have been applied to any copper mineral but it is arbitrarily used for cuprous oxid.

3. *Combined Chemical and Arbitrary Names.*—Still a third method is an attempt to combine the chemical names with arbitrary root-names. This method is used to some extent at present. We have such names as natramblygonite, plumbojarosite, and manganocolumbite, for distinctive minerals. As emphasized before these names are ambiguous and so are objectionable. In fact all such compound names should be discarded, except as indicated above. For varieties, qualifying chemical terms can be used. For example we can use the term ferriferous goslarite instead of ferro-goslarite. For distinctive minerals such as natramblygonite, plumbojarosite, and manganocolumbite it is preferable to use distinctive names.

In a recent paper entitled "Suggestions for Mineral Nomenclature,"<sup>12</sup> H. S. Washington proposes a new system of mineral nomenclature. He uses as a root name for the acid radical of a mineral group the present name of a typical member of the group. This root name is modified by chemical terms to indicate the particular mineral. For the apatite group the root name is *apatate*. Apatite is calcium phosphapatate, pyromorphite is lead phosphapatate, while mimetite is lead arsenapatate. The root name for the sphalerite group is *sphaleride*.<sup>13</sup> The sulfids of this group are called sulfsphalerides, the selenids, selsphalerides, and the tellurids, telsphalerides. Sphalerite itself is called zinc sulfsphaleride, meta-cinnabar, HgS, is mercury sulfsphaleride while tiemannite, HgSe, is mercury selsphaleride and coloradoite, HgTe, is mercury telsphaleride. Calcite is calcium calcitate, siderite is ferrous calcitate, and dolomite is magnesiacalcium calcite. Forsterite is magnesium olivenate. Orthoclase is potassium adularate. Albite is sodium albate, etc.

Washington's proposed system emphasizes the isomorphous relations, but in my opinion that is about the only good point in its favor. As Washington himself admits, the names are barbarous and uncouth. Most of them are also long and cumbersome and so do not

<sup>12</sup> *Amer. Jour. Sci.* (4), Vol. 33, p. 137, 1912.

<sup>13</sup> The termination *-ide* is used for binary compounds and sulfo-salts while the termination *-ate* is used for the oxy-acid salts.

serve the purpose of convenience. For example, the name for the basic calcium phosphate for which I recently proposed the name voelckerite<sup>14</sup> would be something like calcium oxy-phosphatate.

Arbitrary names I believe are preferable to names such as those proposed by Washington. My reasons are as follows:

1. Arbitrary names are stable; there is no necessity for change because of an incorrect analysis.
2. Any name of a new mineral that is proposed stands for the predominant molecule whatever its isomorphous relations may be.
3. Arbitrary names are more convenient than other names because they are shorter.
4. The present names are to a large extent retained and very few names will be necessary.

Most of the present names are so well established by long association that it will be almost impossible to substitute other names for them. The law of priority, with certain limitations,<sup>15</sup> holds in mineralogy as in zoölogy and botany.

Only the professional mineralogist would be apt to use Washington's system, but to him the arbitrary names are not objectionable.

There is one apparent objection that may be urged against my plan. A quantitative chemical analysis will often be necessary to place and name a mineral that is near the dividing line between two isomorphous compounds. This is unfortunate from the standpoint of determinative mineralogy but it is no real objection. It goes without saying that accuracy of definition is based upon accurate work which must often be quantitative in character. As Miers<sup>16</sup> says ". . . it cannot be too strongly impressed upon the student at the outset that scientific mineralogy is based upon accurate measurements and determinations."

There are several points to mention in connection with the recording of chemical analyses of minerals. I think it is well, as I have done in a recent text-book,<sup>17</sup> to record mineral analyses in the form of metals and acid radicals instead of the usual form of oxids. The

<sup>14</sup> *Amer. Jour. Sci.* (4), Vol. 33, p. 475, 1912.

<sup>15</sup> Dana, "System of Mineralogy," 6th ed., p. xliii, 1892.

<sup>16</sup> "Mineralogy," p. v.

<sup>17</sup> "Introduction to the Study of Minerals," New York, 1912.



present method is based upon antiquated notions dating back to electro-chemical theory of Berzelius. The ideal way would be to record the constituent elements. This can be done with haloids, sulfids, and sulfo-salts but not with the oxygen salts for there is no method of determining oxygen directly. If haloids or sulfids are combined with oxygen salts as in minerals of the apatite group there is decided advantage in recording percentages of the metals and acid radicals. In the silicates the acids and acid radicals are not known and it is necessary to use the ordinary oxids as in rock analyses.

In recording analyses it is well to give the molecular ratios of elements and acid radicals in addition to the percentage composition even if the purpose is not to establish a chemical formula.<sup>18</sup> This plan has been proposed for igneous rocks by Washington<sup>19</sup> but might well be extended to cover minerals. Murgoci<sup>20</sup> in an article on the classification of the amphiboles uses a tabulated list of the molecular ratios instead of the more usual percentage compositions.

My suggestions concerning mineral names are far from carried out at present. Out of Spencer's list<sup>21</sup> of about one hundred new mineral names proposed between the years 1907-10 approximately, not more than fifty-five can possibly be regarded as distinct mineral spaces. That is, forty to fifty names proposed within this short time are, in my opinion, practically useless. There are glendonite, pseudopirssonite, and pseudostruvite, names for pseudomorphs. Fermorite, anemousite, spandite, and grandite are isomorphous mixtures. Spandite is an isomorphous mixture of spessartite and andradite, while grandite is an isomorphous mixture of grossularite and andradite. While these names may occasionally be convenient they only increase the difficulty of naming a mineral. The names are not exact for the limits are not defined. Azurmalachite, sefströmite, and leesbergite are mechanical mixtures. Alomite,

<sup>18</sup> The tables in Kemp's "Handbook of Rocks," 5th edition, pp. 171-177, will be found useful in converting percentage compositions into molecular ratios.

<sup>19</sup> *Amer. Jour. Sci.* (4), Vol. 10, p. 59, 1900.

<sup>20</sup> *Bull. Dept. Geol., Univ. of California Pub.*, Vol. 4, pp. 377 and 383.

<sup>21</sup> *Mineralogical Magazine*, Vol. 15, p. 415, 1910. For previous lists see *ibid.*, Vols. 11, p. 323; 12, p. 378; 13, p. 363; and 14, p. 394.

bonamite, ricolite, satellite, and vredite are trade-names of semi-precious and ornamental stones. Aglaurite (orthoclase), bravoite (pyrite), hallerite (paragonite), cobaltocalcite (calcite), isomicrocline (microcline), loisite (scorodite), neslite (opal), magnesium-pectolite (pectolite), pulleite (apatite), tawmawite (epidote) are simply varieties of the minerals indicated. Still other names are synonyms but these are often unavoidable.

The task of descriptive mineralogy is to establish and define the distinctive minerals or mineral species but the science is greatly handicapped by hundreds of varietal names which are worse than useless.

In conclusion let me urge that in the future new names be given to *bona fide* mineral species only and that distinctive names of varieties, pseudomorphs, and mixtures be discarded as far as possible.

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May, 1913.